Habitat Value of Natural and Constructed Wetlands Used to Treat Urban Runoff: A Literature Review

Summary of the Findings and Recommendations

The idea of creating or restoring wetlands to treat urban runoff has recently gained popularity. Members of the Southern California Wetland Recovery Project have raised questions about the technical feasibility and compatibility of providing both water quality improvements and high quality wildlife habitat in wetlands. In response, the California State Coastal Conservancy commissioned the Southern California Coastal Water Research Project to provide a scientifically credible baseline of information from which we may begin to address these questions. A brief summary of the findings and recommendations presented in "*Habitat Value of Natural and Constructed Wetlands Used to Treat Urban Runoff: A Literature Review*" (http://www.coastalconservancy.ca.gov/scwrp/index.html) are as follows:

1. **Limited information exists about the potential impacts to habitat and wildlife from treating urban runoff in wetlands.** Most literature addresses pollutant removal efficiency, polishing of municipal wastewater, and impacts of urban runoff on natural wetlands. No studies specifically address how using wetlands to treat urban runoff will affect wildlife over the long term.
2. **Literature about the impacts from urban runoff entering natural wetlands suggests that caution is warranted.** The following concerns should be recognized:
    - Wetland type may be converted**.**
    - Evidence shows that pollutants in urban runoff may lead to a shift in community composition, a reduction of species diversity, or potential toxicity to species.
    - Species diversity and population counts are an indication of <u>habitat attractiveness</u> but not necessarily of <u>habitat quality</u>.
3. **A wetland constructed to maximize treatment has a different physical design than a natural wetland.** For example,
    - The optimum physical and biological features for water treatment are very different from those for high quality stream habitat.
    - Topographic complexity, an important feature for the biogeochemistry and ecology of natural wetlands, may be lower for constructed treatment wetlands or become lower upon receipt of storm water or urban runoff.
4. **A research program based upon a risk-assessment approach is needed to understand the tradeoffs between habitat and water quality functions when treating urban runoff in wetlands in southern California's arid environment.** See attached summary.
5. **Suggestions in the literature provide a starting place for guidelines to proceed with these projects in the interim, while the uncertainties are addressed.** See attached summary.

Siting, Design, and Management of Treatment Wetlands: Recommendations from the Literature

Landscape Planning Considerations

Siting of treatment wetlands should be part of a watershed-wide planning effort that includes a comprehensive water quality management strategy

- Maximize water storage and infiltration opportunities outside of existing wetlands to minimize runoff.
- Consider decentralized treatment wetlands throughout the watershed over one large treatment wetland.
- Research historic extent of natural wetlands within watershed and locate treatment systems where there is minimal opportunity to restore historic or natural wetlands.
- The installation of treatment wetlands in a watershed should be coupled with a program to preserve open space and mature forest cover and restore riparian buffers around streams and wetlands.
- In wetlands and streams whose hydrology has been disturbed, consider managing storm water and low flow runoff to match, as close as possible, the predevelopment hydroperiod and hydrodynamic.
- Since evidence suggests that urban runoff may affect natural wetlands, consider strategies that improve urban runoff quality before it enters natural wetlands or aquatic habitats.
- If habitat benefits are desired, then assess whether the water to be treated or sediments are of adequate quality to support wildlife.

Design Considerations

A well-conceived design for a constructed wetland is critical not only to mitigate any potential impacts to wildlife but also to assure a high level of treatment performance.

- Hydraulic and Contaminant Loading Rates: Given lack of guidelines for southern California, size treatment wetlands to allow for conservative hydraulic and contaminant loading rates.
- Importance of Source Control and Pretreatment: Literature suggests that wetlands should not be the first interceptor of urban runoff, particularly in industrial or highly urbanized sites. Specific recommendations include:
  - Control source of pollutants where possible
  - Depending on land use, provide pretreatment including: 1) oil and grit interceptors in highly industrial sites, highways, etc. , 2) sand filters or forebays and floating berms to trap trash and large debris prior to or at beginning of wetland such that the remainder of the wetland is used for polishing and/or wildlife enhancement, and 3) incorporate a variety of treatment strategies in series to maximize removal efficiencies and minimize exposure to wildlife.
- Maximize Native Habitat and Plant Diversity: Because the plant palette is one of the major controls on habitat quality in a treatment wetland, the following recommendations be considered in the design:
  - Where appropriate, design constructed treatment wetland to provide habitat with a diversity of native species comparable to similar wetlands in the region.
  - Create gentle slope to allow for good plant establishment and diversity.
  - Design for moderate water level fluctuations.
  - Maximize vegetative species diversity, where appropriate. Research is needed to determine which native upland and wetland plant species are compatible for treatment wetland use.

Maintenance

Long-term, regular maintenance of treatment wetlands is critical to sustain treatment capacity and optimize the habitat value provided and should be required indefinitely. All maintenance work must be scheduled to avoid critical breeding and nesting periods for wetlands species.

Importance of Monitoring and Adaptive management

US EPA strongly recommends long-term monitoring of treatment wetlands to ensure that the system is functioning properly and not becoming an attractive nuisance to wildlife. See Chapter 5 for more details.

Excerpted from Chapter 5, Habitat Value of Urban Runoff Treatment Wetlands: A Literature Review. These recommendations should be not be considered a complete or detailed compilation but rather a starting point for future discussion with stakeholders. Any guidelines adopted must be constantly revisited as additional research is completed.

Research Recommendations

Below is an initial list of research needs required to assess the potential hazards associated with treating wet and dry season urban runoff in wetlands of arid/semi-arid climates. A risk assessment paradigm is useful to examine these issues and consists of two components: (1) an exposure assessment quantifies the potential level of damage to the habitat and (2) an ecological effects assessment evaluates the effect of the damage or contamination to a particular species or community. Given that different agencies or organizations may have different priorities, no attempt was made to prioritize the list of research needs. Rather, prioritization of a research agenda should be done via consensus involving all appropriate entities.

Exposure Assessment

1. What are wet and dry season pollutant concentrations and loading rates from specific land uses?
2. What is effluent quality of treatment wetlands (constructed and natural) and riparian areas in semi-arid/arid climates under a range of contaminant loading rates and over time?
3. What are the natural background concentrations of contaminants in the surface waters of wetlands and riparian areas in southern California? How do they vary spatially (both by position within the watershed and between watersheds) and temporally over seasonal or climatic cycles?
4. How does diversion of wet or dry season flow into wetlands and riparian areas determine 1) physiochemical characteristics (pH, conductivity, alkalinity), 2) sediment deposition rates, texture and grain size distribution, and organic matter content, 3) hydrologic regime including seasonal and annual water budgets, 4) storage, transport, and seasonal/annual budgets of contaminants?
5. What is the maximum allowable change in peak flow rate and duration, water level, and other hydrologic variables that can result without deleterious effects to habitat values (by wetland class)?

Ecological Effects Assessment

1. What are the most appropriate assessment endpoints to evaluate risk (e.g., plant chlorosis, decreases of microbial communities, changes in species composition, reproductive failure)?
2. How does biotic community composition/trophic structure compare between treatment vs. natural wetlands?
3. What is the sensitivity of key plant or animal species to contaminant loading and accumulation?
4. What are the rates of bioaccumulation of contaminants at various trophic levels?
5. Is toxicity observed in macroinvertebrates, fish, amphibians, or birds that live, forage, or breed in wetlands exposed to urban runoff? Are specific life stages or species more sensitive than others? What are the most appropriate biological indicators for monitoring toxicity?
6. What is the habitat value of treatment wetlands on a landscape scale?

Mitigating Risks to Wildlife and Maximizing Habitat Benefits

Research on the effect of specific design or maintenance practices on wildlife will improve our ability to optimize wetland management for both wildlife and water quality goals.

1. What are the appropriate design criteria for wetlands treating wet weather and dry weather urban runoff if providing habitat is a primary or secondary objective? What are the appropriate design criteria if the objective is to construct a treatment wetland and not attract sensitive species?
2. What other treatment wetland design attributes contribute to improving habitat in wetlands?
3. What is the effect of pretreatment on reducing contaminant loading to the main wetland or riparian area? What is the extra burden in cost and labor that such pretreatment strategies impose?
4. To what extent does routine maintenance in forebays and main wetland cause a disturbance or diminish habitat value? What are recommended ways to minimize this disturbance?
5. What plant species native to southern California are most suitable for cultivation in treatment wetlands (i.e., the most flood and contaminant tolerant)? What are the recommended native plant palettes with respect to different habitat types within a treatment wetland?
6. What source control/treatment BMPs are appropriate as part of an overall water quality program?